UNIVERSITY OF PATRAS
DEPARTMENT OF ECONOMICS

ENERGY ECONOMICS

Academic Year 2022-2023
Winter Semester
Lecture 4th-5th
Energy supply and energy markets

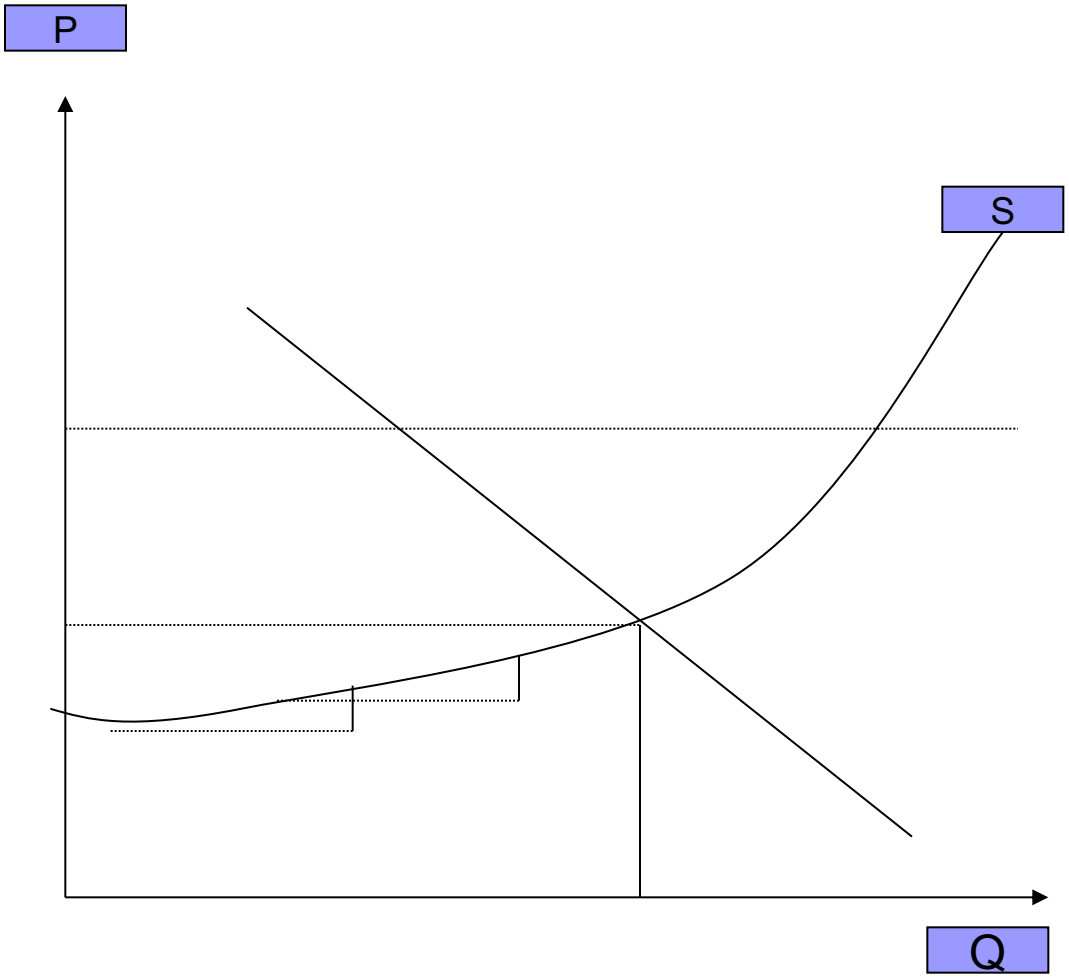
Tutor: Dr. Kounetas Kostas, Associate Professor

Οικονομικά της Ενέργειας (Energy Economics)

4th-5th Lecture: The energy supply-Energy Markets

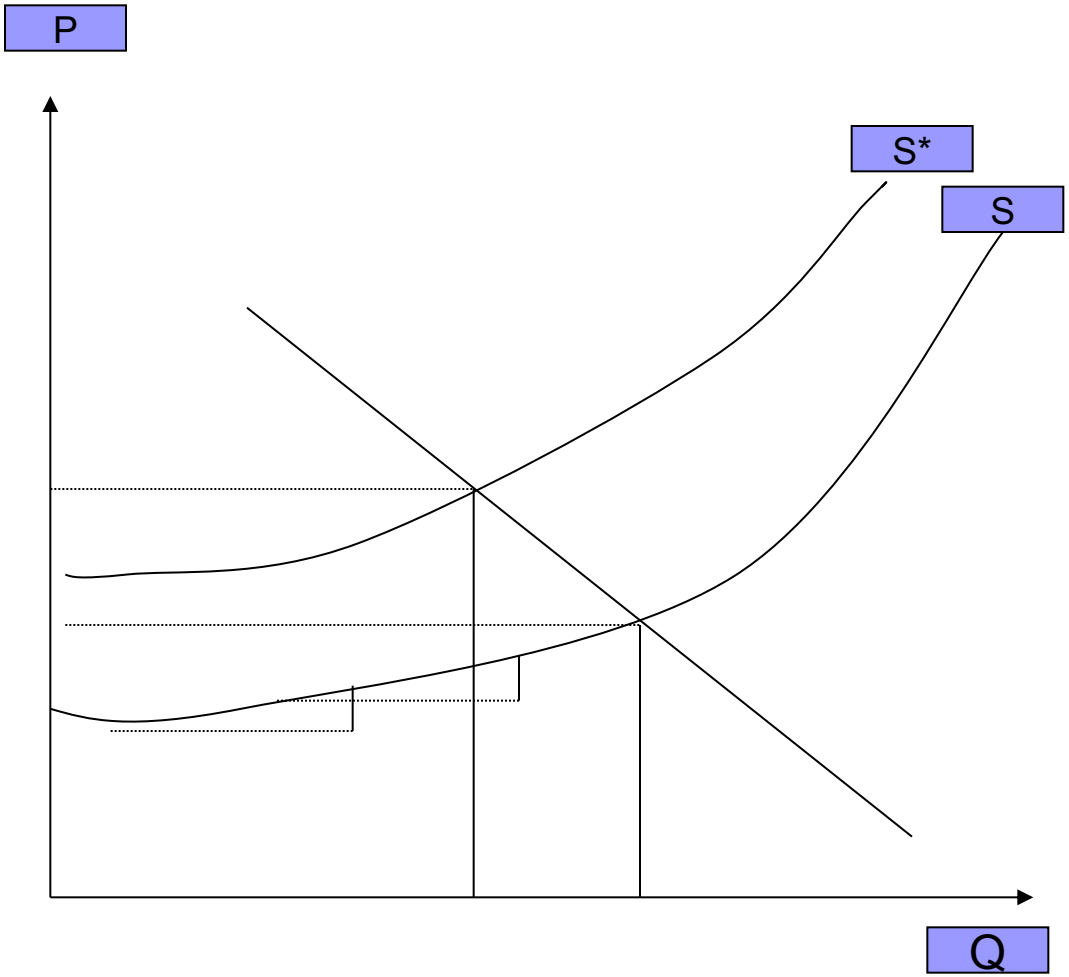
- Energy supply economies deal with the way energy resources are made available through space and time. Generally speaking, energy resources can be classified as either exhaustible or non-exhausted.
- A resource is considered depletable when the sum of the time of each possible production is finite, or the resource pool can not be replaced in a reasonable time (crude oil, natural gas and coal - fossil fuels - are examples of exhaustible resources). Economists deal with them mainly because of fossil fuels.
- A resource is considered non-depletable if its stock can be replenished within a reasonable period of time (Unlimited energy sources include geothermal, wind and solar).
- Hotteling (1931) r-rule with several theoretical studies of optimal extinction rates and related pricing rules. Not always accurate as technological change in the extractive industries, the development of lower cost alternatives, widening the resource base through exploration activities, uncertainty in reserve estimates largely affected the model.
- The assumptions made in this lecture concern the competitive market and consider consumers to want to maximize their usefulness and producers the profits given the limitations that apply.
- There are many consumers and producers trying to trade on the market.All factors are price receptors and there is no power in the market of each factor.For consumers, what measure could we use as utility is not observed?

A graphical Analysis



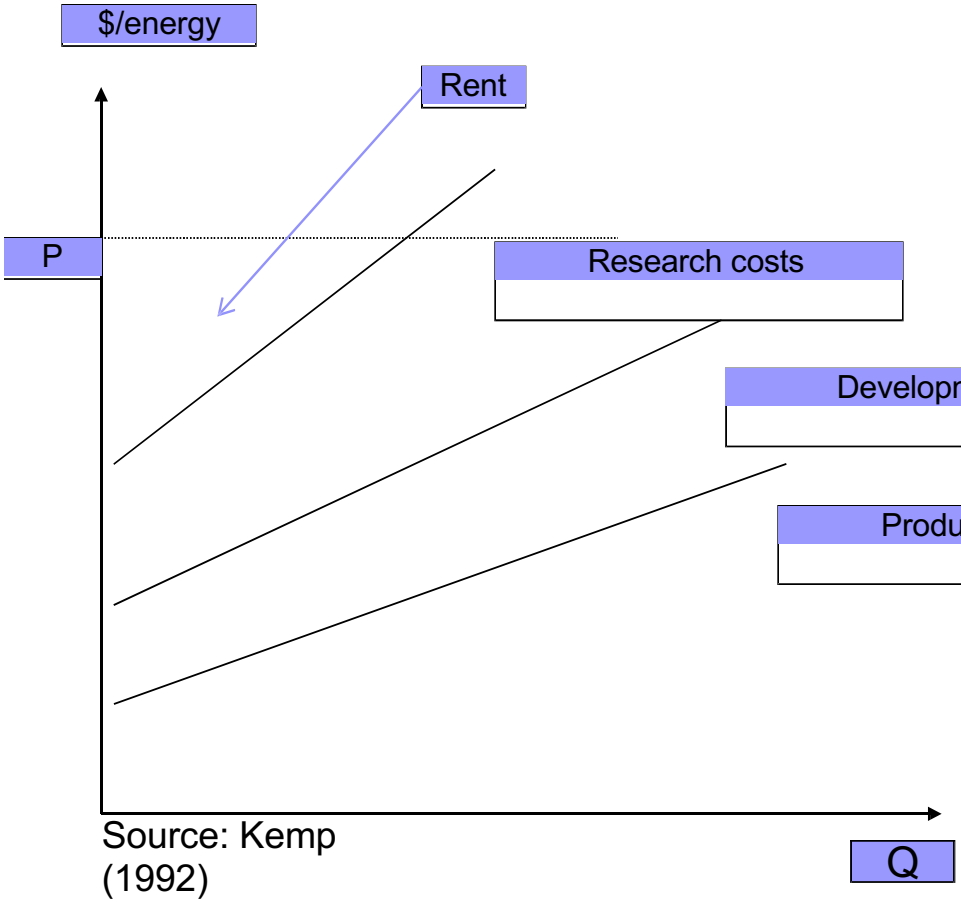
- Each supplier participates in the market depending on its cost of production. Normally, the lowest cost producer is first called upon to supply, followed by the next costly producer. This process continues until demand is met.
- Those suppliers with cost below the market clearing price are called to produce. The marginal producer only recovers the operating cost while the rest would cover more than their respective marginal costs.
- In such a condition, the low cost operators should produce more while the high cost operators should provide the marginal output .
- Thus, even in a competitive market situation, the profit earned depends on the cost of production and demand for the output.

Low cost supplier case



- A low cost supplier would push the costs down and introduce a rescheduling of suppliers who would be called upon to supply the fuel. Displace the costly suppliers and some producers who were supplying earlier may find it difficult to sell their outputs. The supply curve moves outward and the prices in the market falls, which encourages more consumers to enter the market.
- Thus, demand increases, price falls and some producers are unable to compete and driven out of the market.

Rent



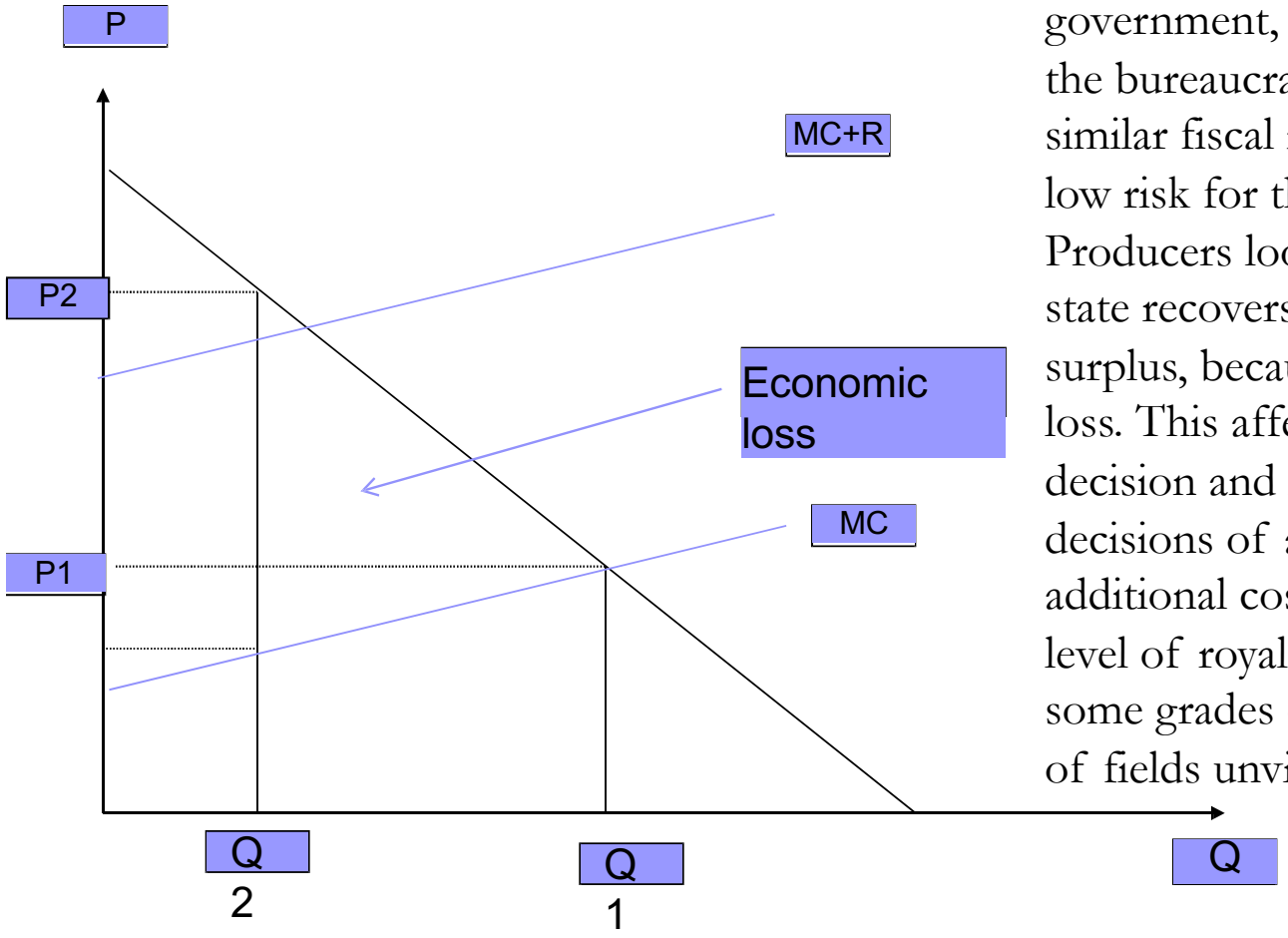
Source: Kemp (1992)

Following Percebois (1989) four rent types can be met.:

- mining rent due to geological conditions: those fields which could be exploited
- technological rent: this arises due to use of a more efficient technology that reduces the costs of production;
- positional rent: proximity to markets offers added benefits to producers by
- •quality rent: arises due to a favourable chemical or physical characteristics of a fuel.

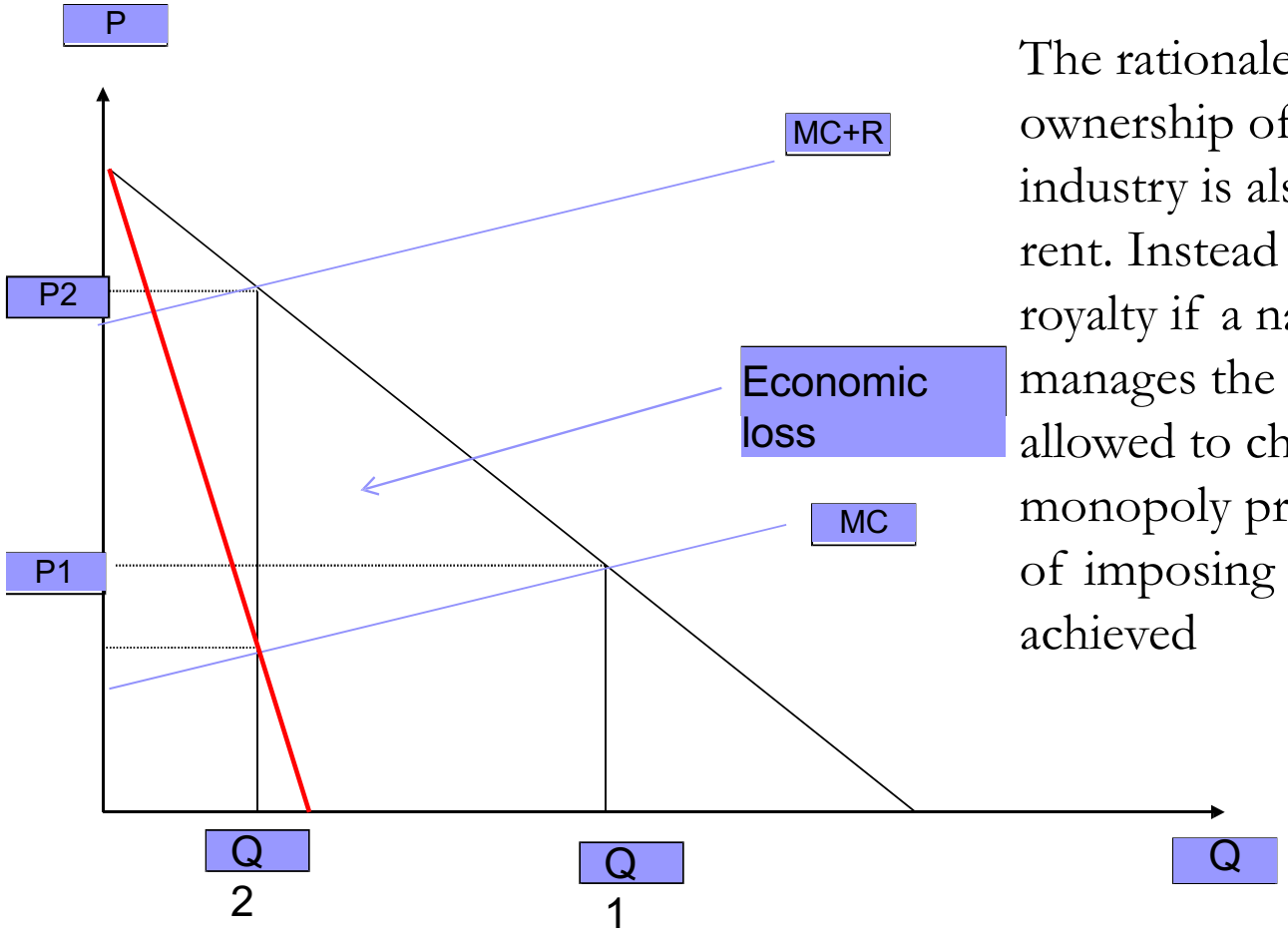
4)Quality rent

Royalty effect



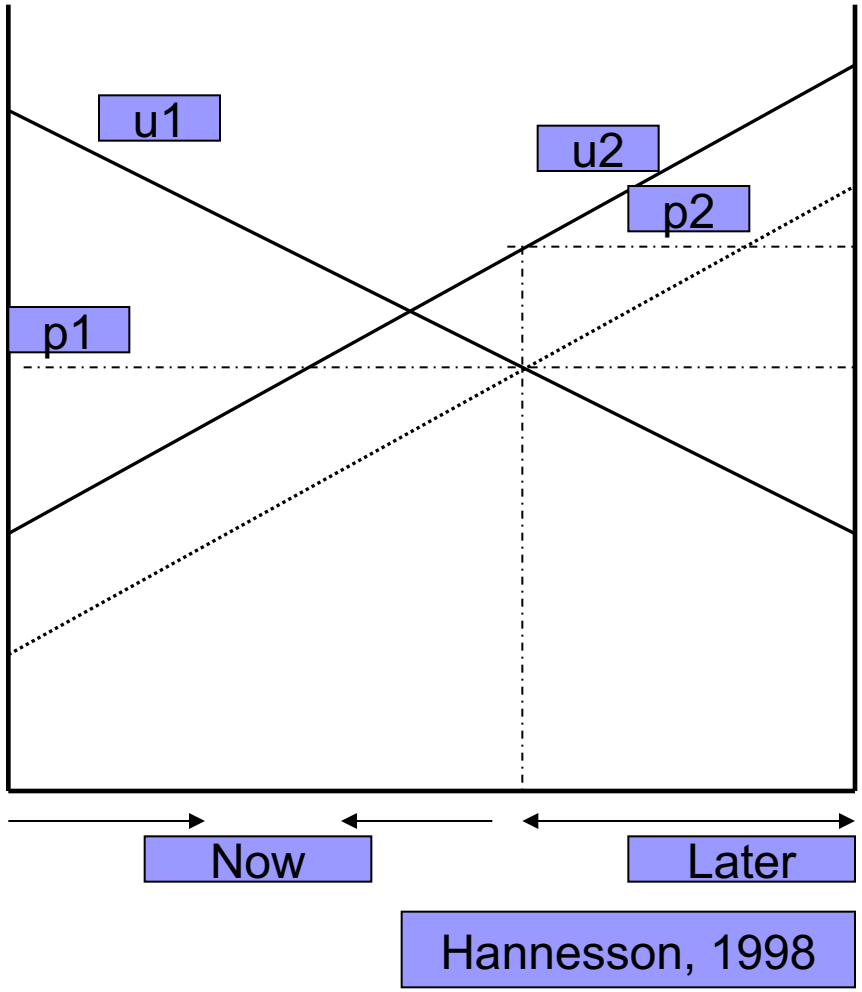
The royalty generates revenue for the government, is easy to administer (as the bureaucrats are quite familiar with similar fiscal measures) and involves low risk for the government. Producers loose more than what the state recovers from the producers' surplus, because of the deadweight loss. This affects their investment decision and influences the operating decisions of a field. A royalty is an additional cost to the firm and a high level of royalty can make extraction of some grades of the fuel or some sizes of fields unviable.

Monopoly Pricing



The rationale behind state ownership of the rent generating industry is also to capture the rent. Instead of a royalty if a national company manages the industry and is allowed to charge monopoly prices, the same effects of imposing a royalty would be achieved

Now or Later?



The amount of resource that used at time 1 is measured from the left side, while the quantity used in time 2 is measured from the right side. If the resource is consumed now, no is available for the next one period. In the absence of his preference time to use resources, the point of intersection of the two curves utility gives the quantities which should be consumed in two periods. Therefore, it must expect the marginal utility in the second period so as to be comparable to marginal utility in period 1.

$$\frac{u_2}{u_1} = (1+r) \quad \frac{u_2}{u_1} = \frac{p_2}{p_1} = (1+r)$$

A simple model of depleting energy source

$$\max_q \sum_{t=0}^{T} \beta^t \left(p_t q_t - c(q_t) \right)$$

$$s.t \quad R_{t+1} - R_t = -q_t$$

$$c, q, R \geq 0$$

β=1/(1+r)

$$\max_q \sum_{t=0}^{T} \beta^t \left(p_t q_t - c(q_t) \right) + \lambda \left(Q^* - \sum_{t=0}^{T} q^t \right)$$

Depletable energy sources

$$s.t \quad Q^* - \sum_{t=0}^{T} q^t = 0$$

$$c, q, R \geq 0$$

What is λ?

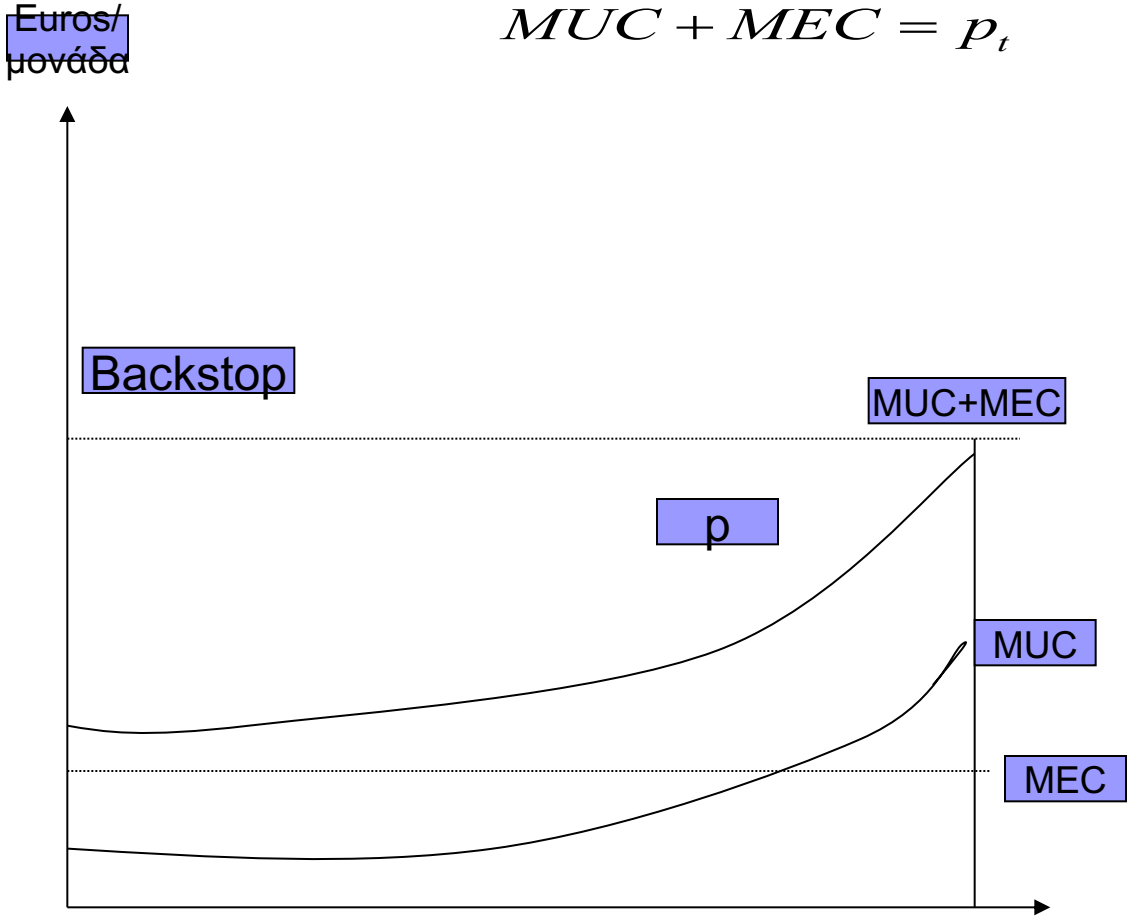
$$\beta^0 \left(p_0 - c(q_0) \right) = \ldots = \beta^t \left(p_t - c(q_t) \right) = \beta^{t+1} \left(p_{t+1} - c(q_{t+1}) \right)$$

$$\left(p_{t+1} - c(q_{t+1}) \right) = (1 + r) + \left(p_t - c(q_t) \right)$$

Over the marginal extraction costs

$$p_t = (1 + r)^t \lambda + c(q_t)$$

$$p_t = (1+r)^t \lambda + c(q_t) \Leftrightarrow$$
$$MUC + MEC = p_t$$



The key role of backstop technologies or new Energy Technologies resources of non-exhaustible or energy resources that can be exhausted at a higher cost. Exhaustion leads to transition fuels.

Example with linear demand I

If time is finite but unknown first order derivatives are in the form. $\beta^0\left(p_0 - c\left(q_0\right)\right) = \ldots = \beta^t\left(p_t - c\left(q_t\right)\right) = \beta^{t+1}\left(p_{t+1} - c\left(q_{t+1}\right)\right)$

In the case where the demand is linear we can by replacing

and extending the condition β to have:

$$p_t = (1+r)^{t-t}\left(a - c(q_t)\right) + c\left(q_t\right) \Leftrightarrow p_t = MUC + MEC$$

Maximum willingness to pay

Introduces a value for the last resource resource exported. If they exist multiple fuel, α determines the transition value either in an alternative fuel or some backstop technology.

Example with linear demand II

Calculating the quantity is easy enough with a simple replacement.

$$q_t = \frac{a - (1+r)^{t-t}(a - c(q_t)) + c(q_t)}{b}$$

Because costs are stable over time we are talking about natural resource depletion. Economic exhaustion is achieved when costs increase to the point where the resource is no longer profitable for export.

What if the interest rate increases?

Similarly, if the value of a decreases?

What is the role of innovation?

Monopoly I

We extend the basic model to look at it in the case of a monopoly undertaking rather than that acting in a perfectly competitive market. In fact, this is of particular interest, given the nature of the world crude oil market, and has been adopted by many researchers (Stiglitz 1976). In one a market characterized by incomplete competition, mining decisions affect prices as much as decisions for the production of the Petroleum Producers Organization Countries (OPEC) affect the global price of crude oil.

Monopoly II

In the monopoly case we can see that $MR_{t+1} = (1+r)MR_t$

With elasticity constant we have that $p_t = \frac{a}{q_t^b}$

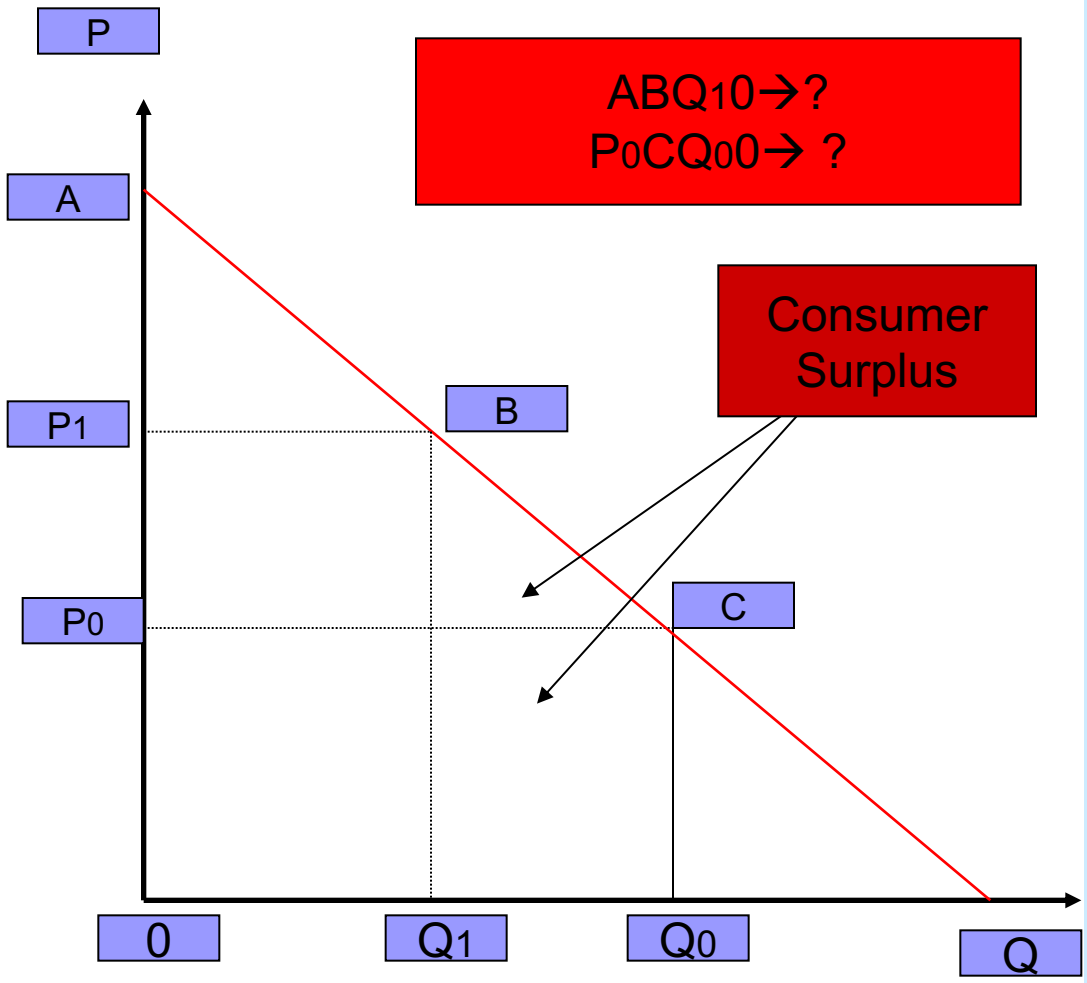
$$aq_{t+1}^{-b} = (1+r)aq_t^{-b} \Leftrightarrow p_{t+1} = (1+r)p_t$$

This stems from the fact that the revenue is the same for each point along a constant elasticity demand curve, so that the monopoly can not does something better than limiting production. If the elasticity is not stable, then the monopolies resources will increase prices in the current period with limiting the level of production (greater resource duration).

Assumptions

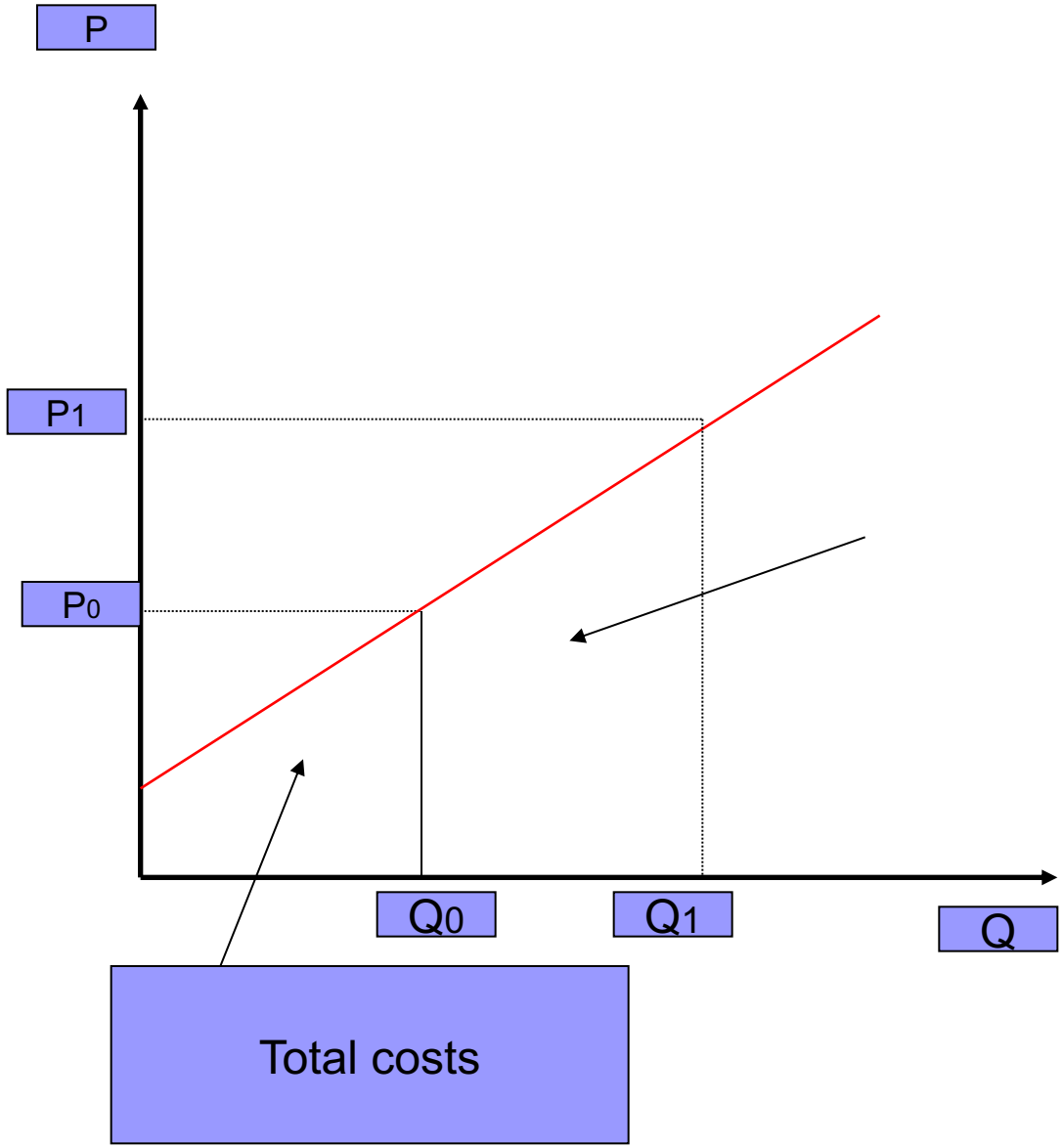
- Mining costs are only a function of current mining
- The total amount of resources is known
- There is no uncertainty
- Export, marketing, and, if permitted, investment exploration, all do occur in a marginal way

Willingness to pay



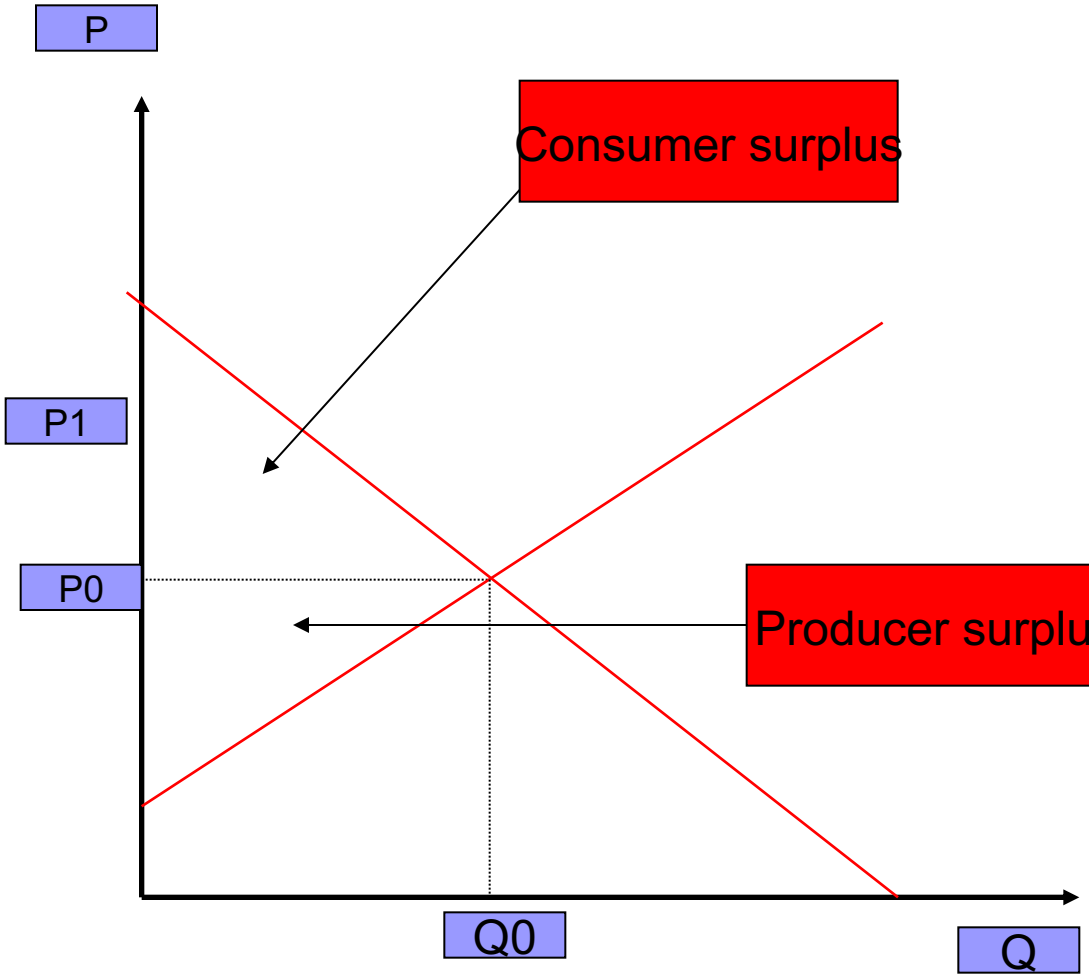
- Consumers satisfy their utility (or preferences) by consuming a good. As utility is not observable, an alternative parameter for measurement of their satisfaction is the willingness to pay or accept to move from a situation to another. At any given price, consumers spend an amount equal to the price times the quantity purchased.
- No consumer is willing to pay for something that she does not want but some consumers may be willing to pay more than the market price. Thus the total willingness to pay at price P0 in is given by the area ACq0O. But the expenditure for the good at this price is given by the area P0Cq0O. The difference between these two areas gives excess benefit consumers obtain, known as "consumer surplus". This is represented by the area left of the demand curve but above the price actually being charged for the good.

Willingness to accept-sell-WTA-WTS



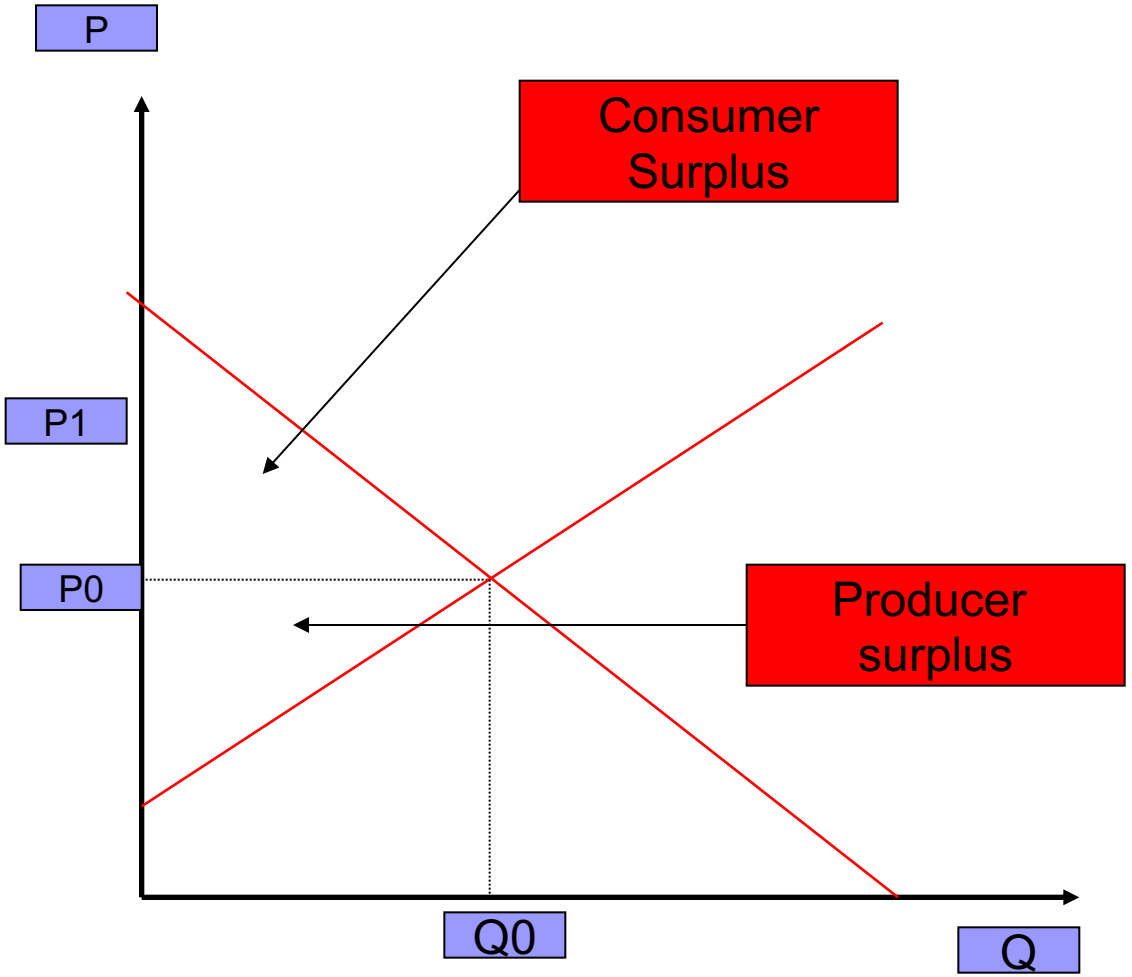
Producers on the other hand may be willing to sell for any given price. However, even at this price, some vendors will receive more benefits due to their low cost productive capacity than others. Surplus producer.

Equilibrium I



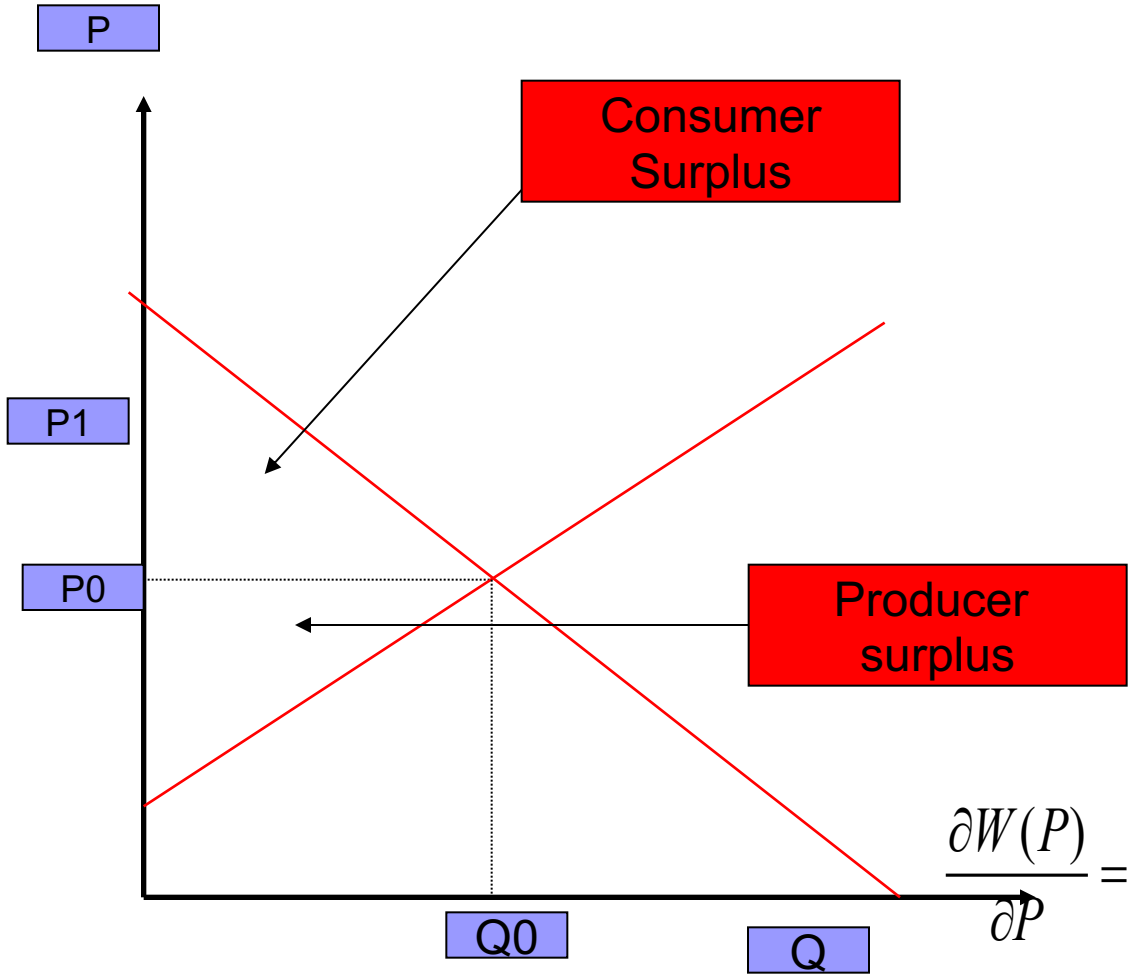
- Competition forces sellers to charge no more than their rivals. If one seller charges more than the market clearing price, consumers will go to others offering the same good at lower price. If someone charges less than the market price, the demand will outweigh supply, forcing a return to the market price. Individual buyers and sellers cannot affect the price. Buyers and sellers react to changes in the market price.
- At lower prices, some sellers will leave the market while more consumers enter it. Similarly, at higher prices more sellers are willing to offer their goods while there will be fewer consumers. The participation in the market is voluntarily and consumers or sellers are free to enter or leave the market in a perfectly competitive case. Price is equal to the marginal cost of the last supplier.

Equilibrium II



Buyers and producers react to changes in market price. At lower prices, some sellers will leave the market, while more consumers will enter, while at higher prices more producers are willing to offer their products while there will be fewer consumers. Market participation is voluntary and producer-producers are free to enter or exit the market in a perfectly competitive case.

A mathematical look



$$CS = \int_{P^*}^{\infty} Q(P)dP$$

$$\pi = PQ(P) - TC[Q(P)]$$

Άρα:

$$W(P) = CS + \pi =$$

$$\int_{P^*}^{\infty} Q(P)dP + PQ(P) - TC[Q(P)]$$

Which is the value that maximizes?

$$\frac{\partial W(P)}{\partial P} = \frac{d}{dP}CS + \frac{d\pi}{dP} =$$

$$-Q(P^*) + \left\{ Q(P^*) + P^* \frac{dQ(P)}{dP} - \frac{dTC[Q(P)]}{dP} \right\} = 0$$

P=MC!!!!!
Pareto optimum

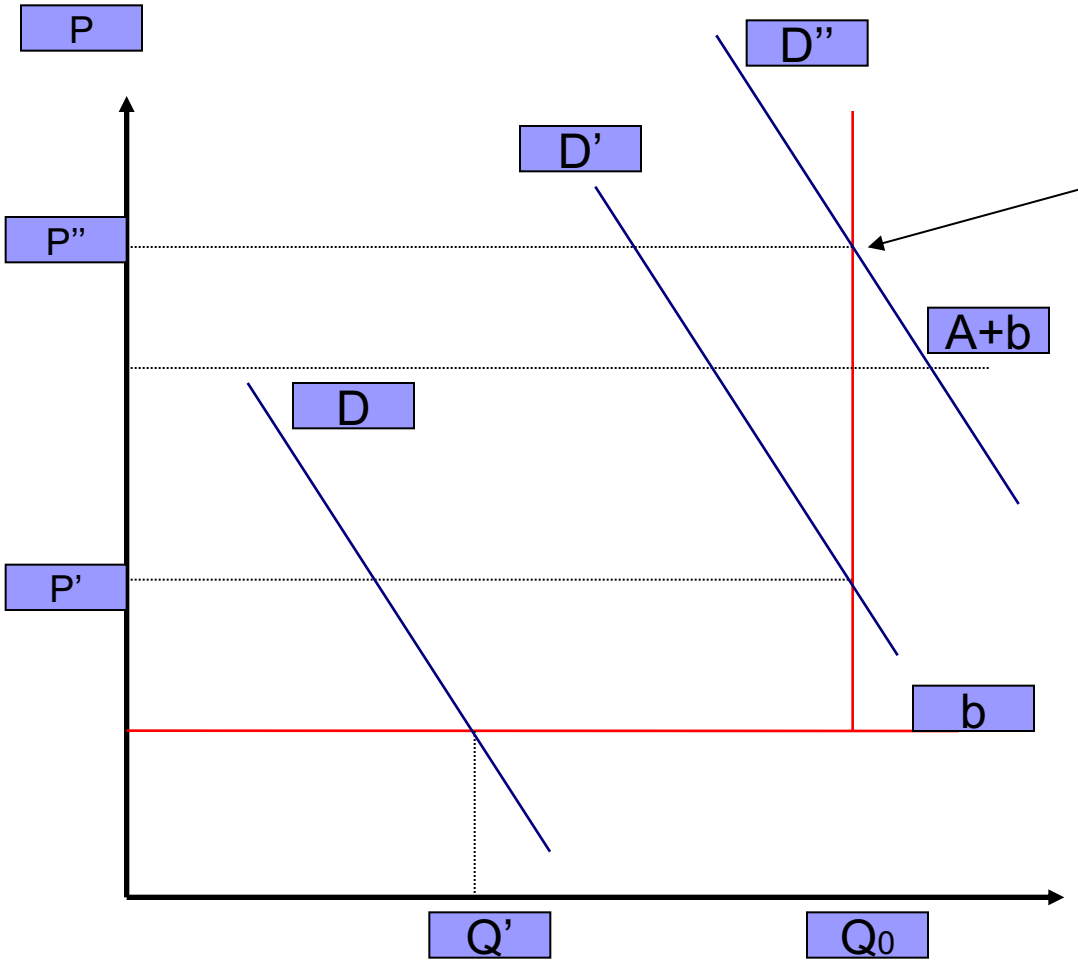
Market specificities

- the participation is voluntary—both consumers and producers enter and exit the market freely, without any compulsion.
- Consumers who are willing to pay the market price enter the market (which means that there could be some consumers who remain outside). Similarly, only those producers will be called to supply whose marginal cost of supply is lower or equal to the price. The marginal producer will recover only his operating costs while other producers who are called to supply would earn some additional profits (which might cover their fixed costs partly or fully depending on their cost structure). This puts pressure on the suppliers to keep their costs low to enter the market. Therefore, there is nothing wrong in a market economy to find price excluding some consumers or producers. Similarly, there is nothing wrong for some producers to earn large profits while others are barely profitable.
- (The relevant pricing principle is essentially a short run one, with an objective of clearing the market.

Extension of the Basic Model

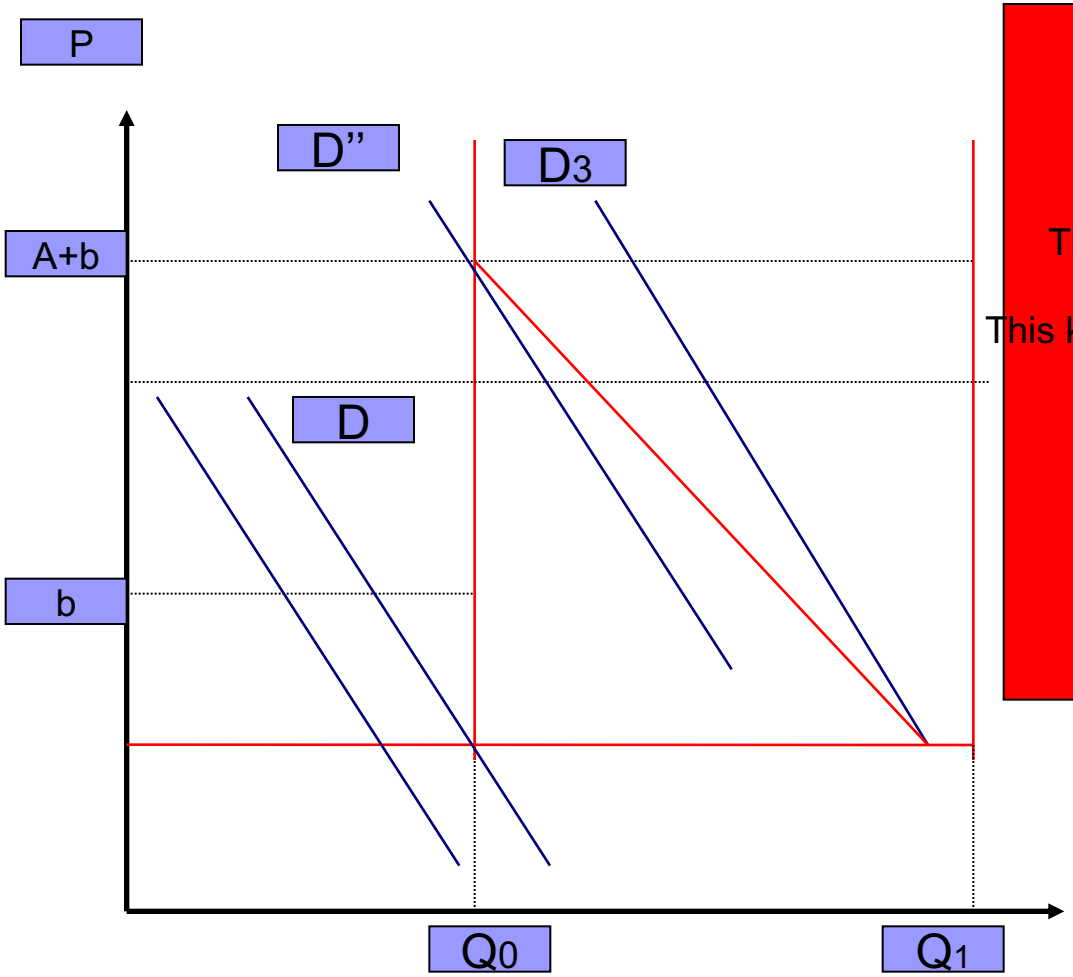
- The indivisibility of capital means that capacity expansion takes place at separate plants of the plant, while lumpy investments have sporadic rather than smooth returns (a common feature in the energy sector). For example, refineries and coal mines have a specific capacity.
- The existence of economies of scale often shows that the cost advantages could be achieved by installing larger sizes.
- The indivisibility of capital changes the shape of the supply curve. Instead of a continuous supply curve, we now have a supply curve for a fixed capacity while the addition of new ones brings sharp changes (or shakes) to the point where investments are made.

Fixed plant case



Excessive profits
to producers
due to itthat the price
exceeded long-term
marginal costs upply

Boom bust cycle



The price goes through a cycle of it instability , bringing explosions and reductions.
This kind of inherent instability of its prices energy is a source of serious concern
affects long-term investment
consumer and investor decisions.

The dimension of exhaustion

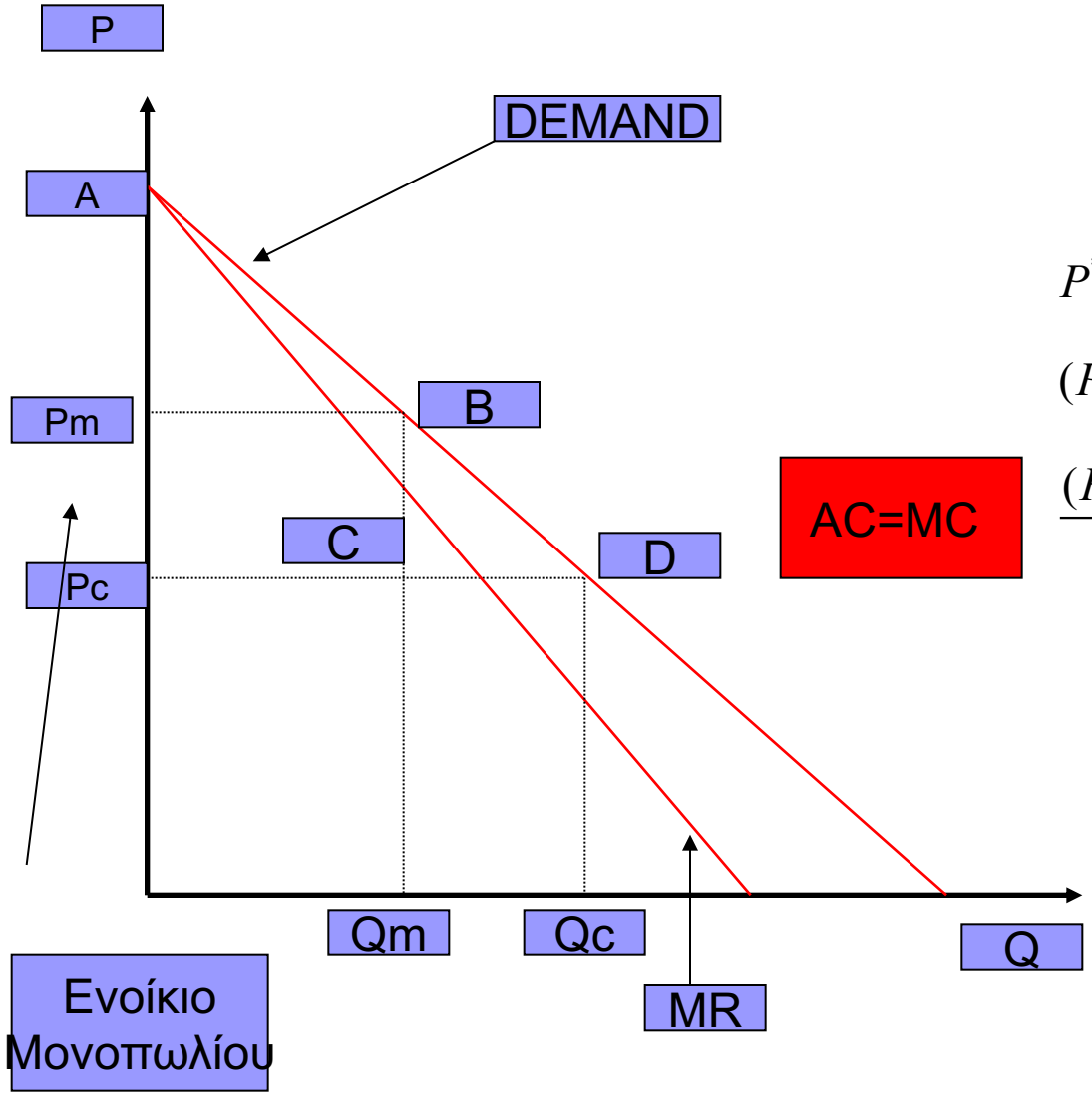
- Since coal, oil and gas are non-renewable resources, consumption of one unit means a loss of consumption at any future date. This brings to another dimension of decision-making: whether you want to use the resource now or later.
- Therefore, the price should be removed from the marginal cost and includes an additional element called rental leeway or cost of use. This means that finite resources have a value beyond their production costs, due to their scarcity

Market failures-Monopoly Problems?

- The characteristic of capital intensity in the energy sector also entails large investments and, consequently, larger plants provide economies of scale, while few large suppliers tend to dominate the market.
- Where will the monopoly set the price?

Market failures-Monopoly Problems 1?

MR=MC.



$$\max PD(P) - TC[D(P)]$$

.

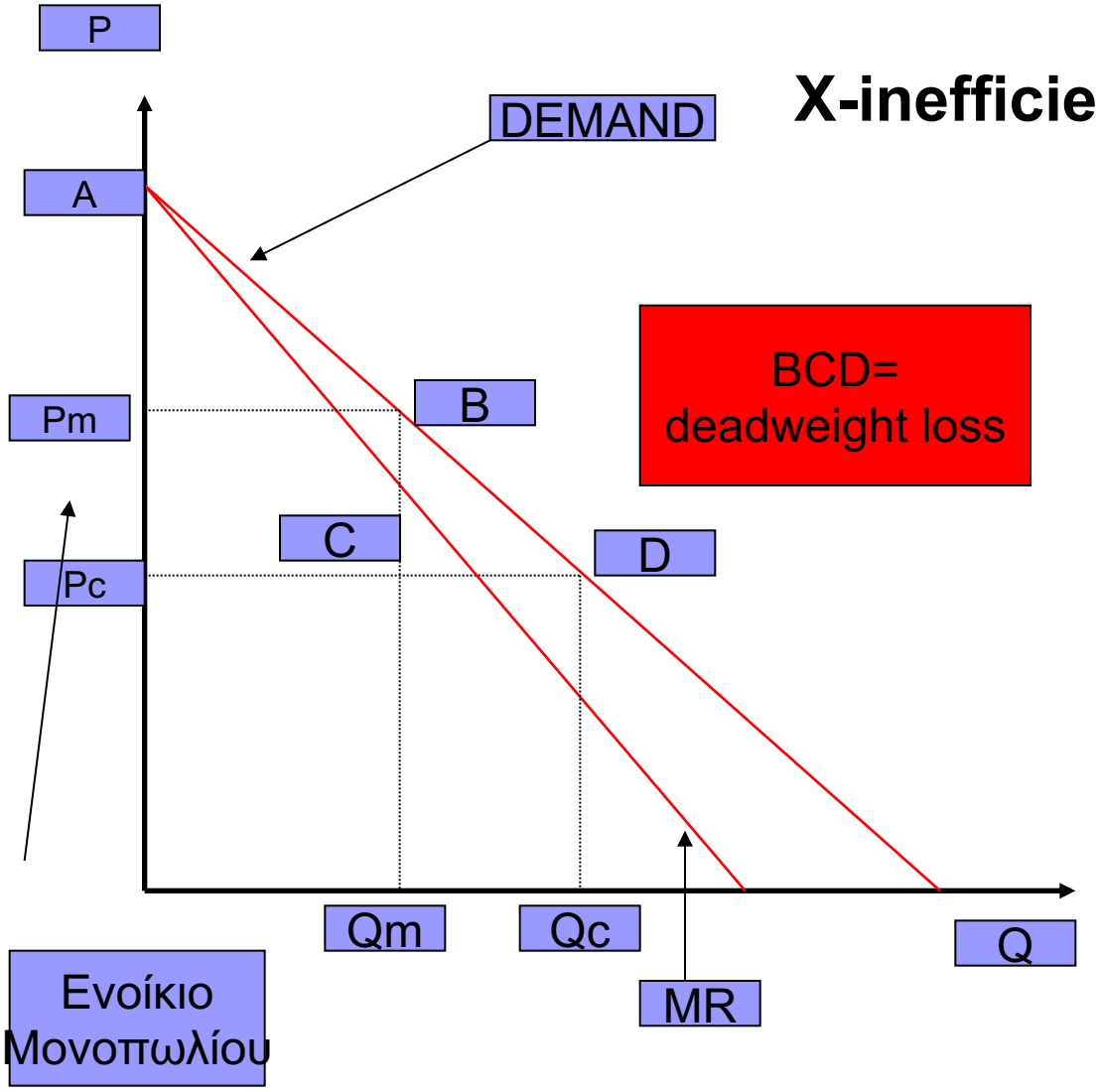
$$P^*D'(P^*) + D(P^*) - TC'(P^*)D'(P^*) = 0 \Leftrightarrow$$

$$(P^* - TC') = {-D(P^*)}\Big/{D'(P^*)} \Leftrightarrow$$

$$\frac{(P^* - TC')}{P^*} = \frac{1}{\varepsilon}$$

In order to maximize the monopoly profits will have to charge consumers with regard to elasticity. So if demand is inelastic the price will be higher or not? What surpluses now?

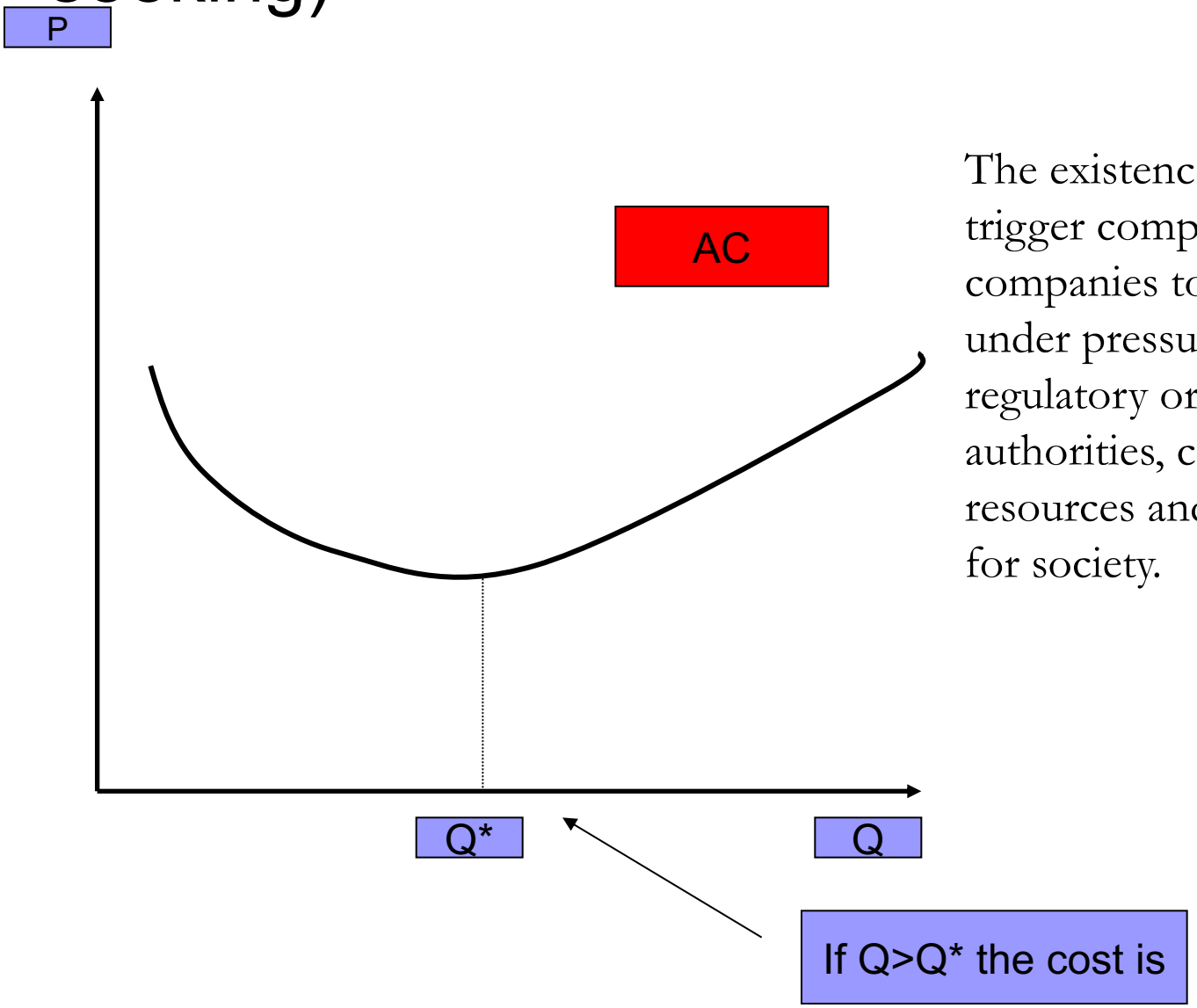
Market failures-Monopoly Problems 2?



X-inefficiency (Leibenstein 1966)

BCD= deadweight loss

Market failures-Monopoly Problems 3? (Rent seeking)



The existence of such a rent will trigger competition between companies to look for rent under pressure and affect regulatory or regulatory authorities, causing wastage of resources and loss of prosperity for society.

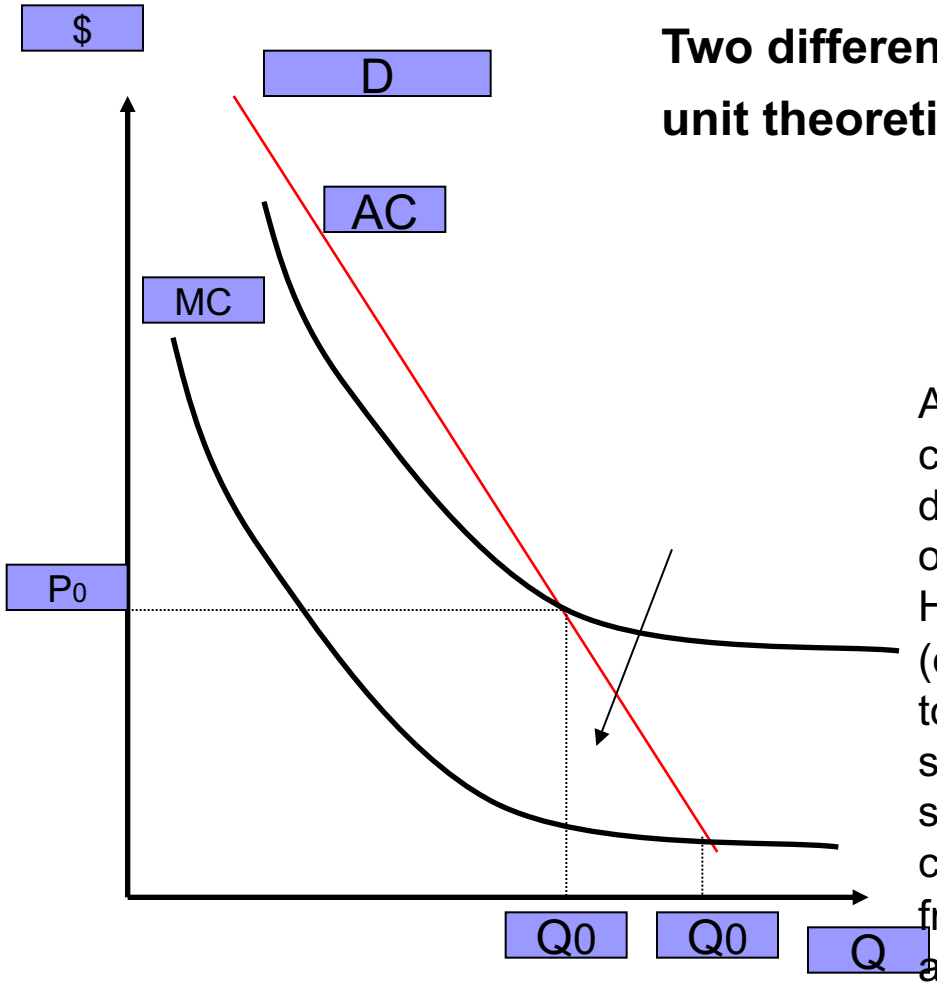
Ramsey pricing

Ramsey pricing is essentially a taxing method that was developed in an attempt to design a system that would lead to minimal deadweight loss. This has then been applied to the pricing issues as well as the basic problem in a natural monopoly subjected to marginal cost pricing is the recovery of losses in a less distorted manner. This principle has been analysed by a number of researcher under various conditions but Baumol and Bradford (1970) provide the most detailed and general analysis of the issue.

$$\frac{(P_i - MC_i)}{P_i} = \frac{k}{\varepsilon_i}$$

Value of services

Two part tariffs system



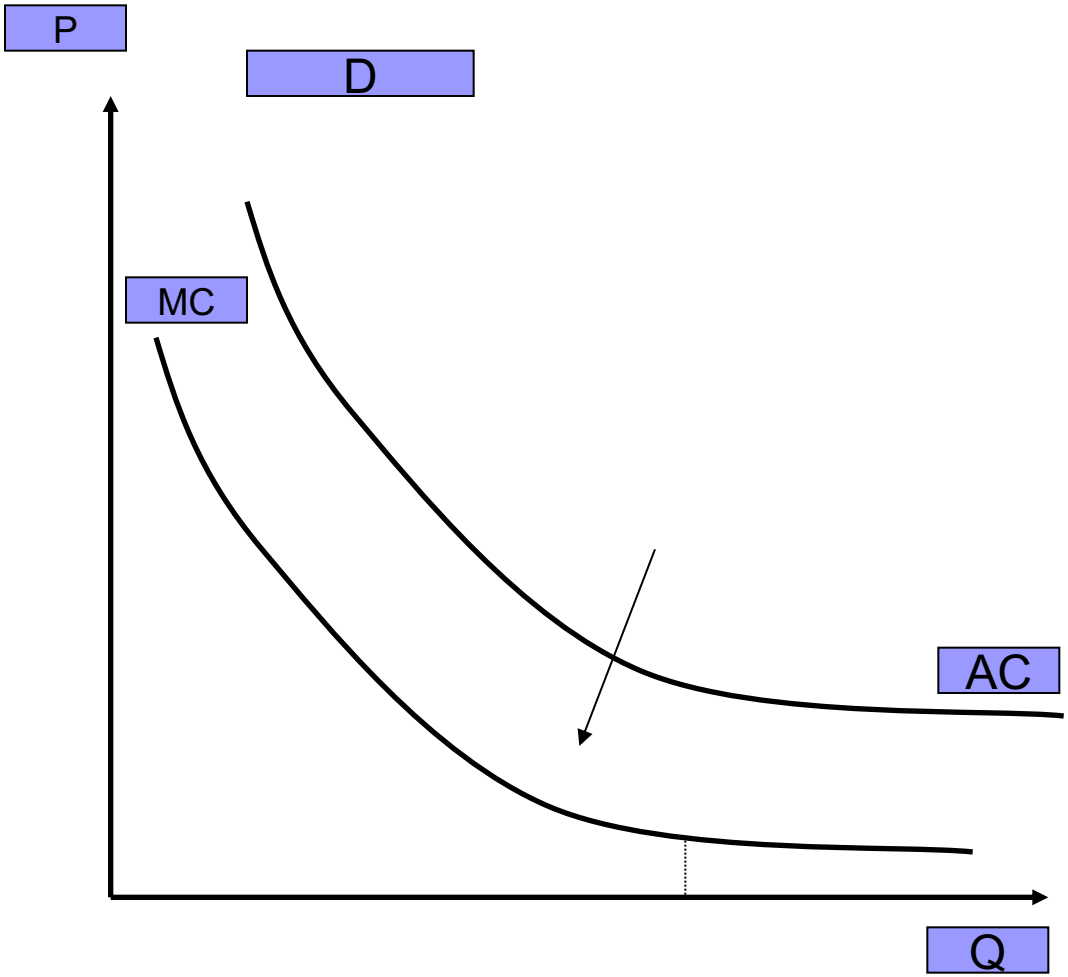
Two different pricing: one fixed and one per unit theoretically equal to the marginal cost.

A simple fee could be a single fee for all customers and will be equal to the total damage to be covered divided by the number of consumers using the service or the good. However, some consumers leave the system (especially those who consume less and have to pay a relatively high fixed fee). An alternative system is a customized design; the fixed fee to suit different consumers or the consumer category. This avoids the problem of exclusion from service but is discriminatory in character and may be illegal in some cases.

Two part tariffs system

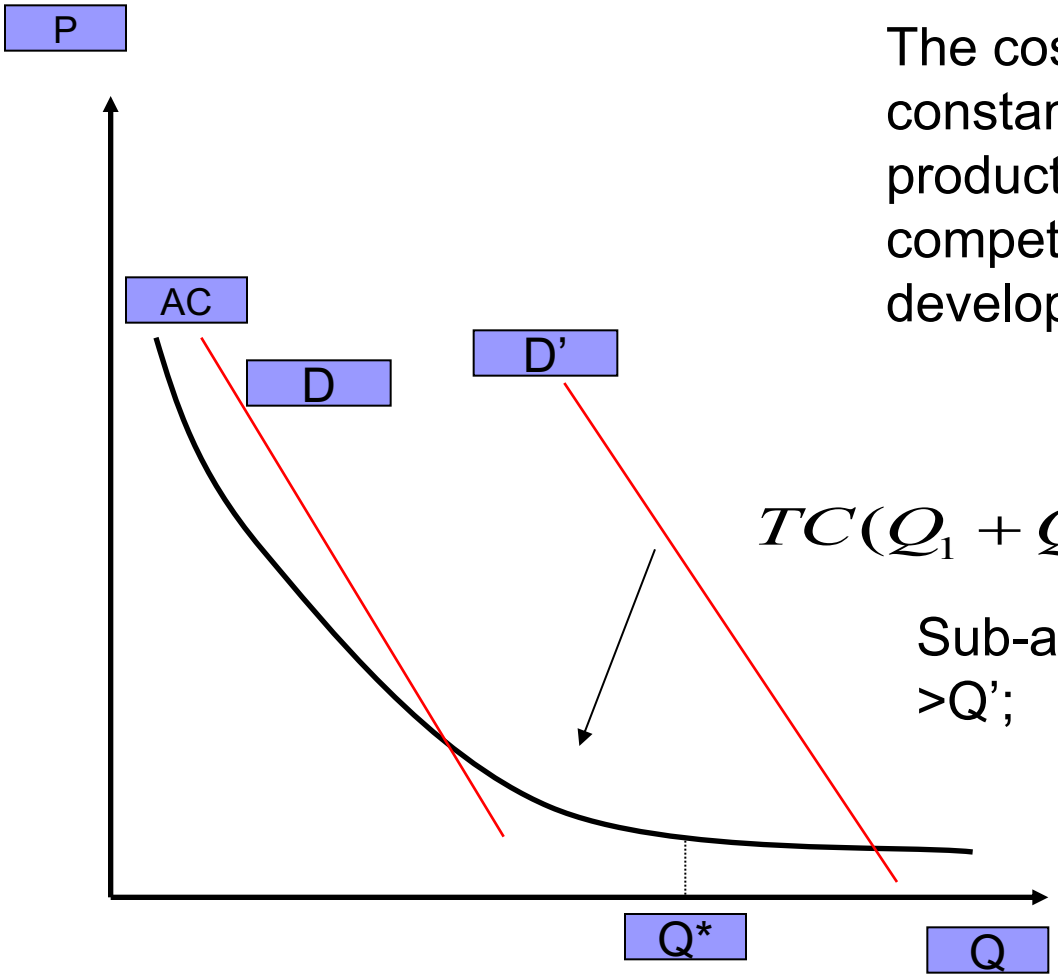
A simple end could be a single end for all of them customers and will be equal to the total loss to be covered divided by the number of consumers using the service or good. However some consumers do abandon the system (especially to those who consume it less and have to pay a relatively high fixed fee).
An alternative system is a customized design the fixed fee to suit different consumers or her consumers. This avoids his problem exclusion from service, but constitutes discrimination nature and may be illegal in some cases.

Natural Monopoly I



The production of a good or one service from one only company ensures at least its offer costs. As the medium cost falls across the spectrum of production, the marginal cost is also reduced. She is a natural case monopoly, because regardless of the size of its demand market, the business can produces at a minimal cost.

Natural Monopoly II

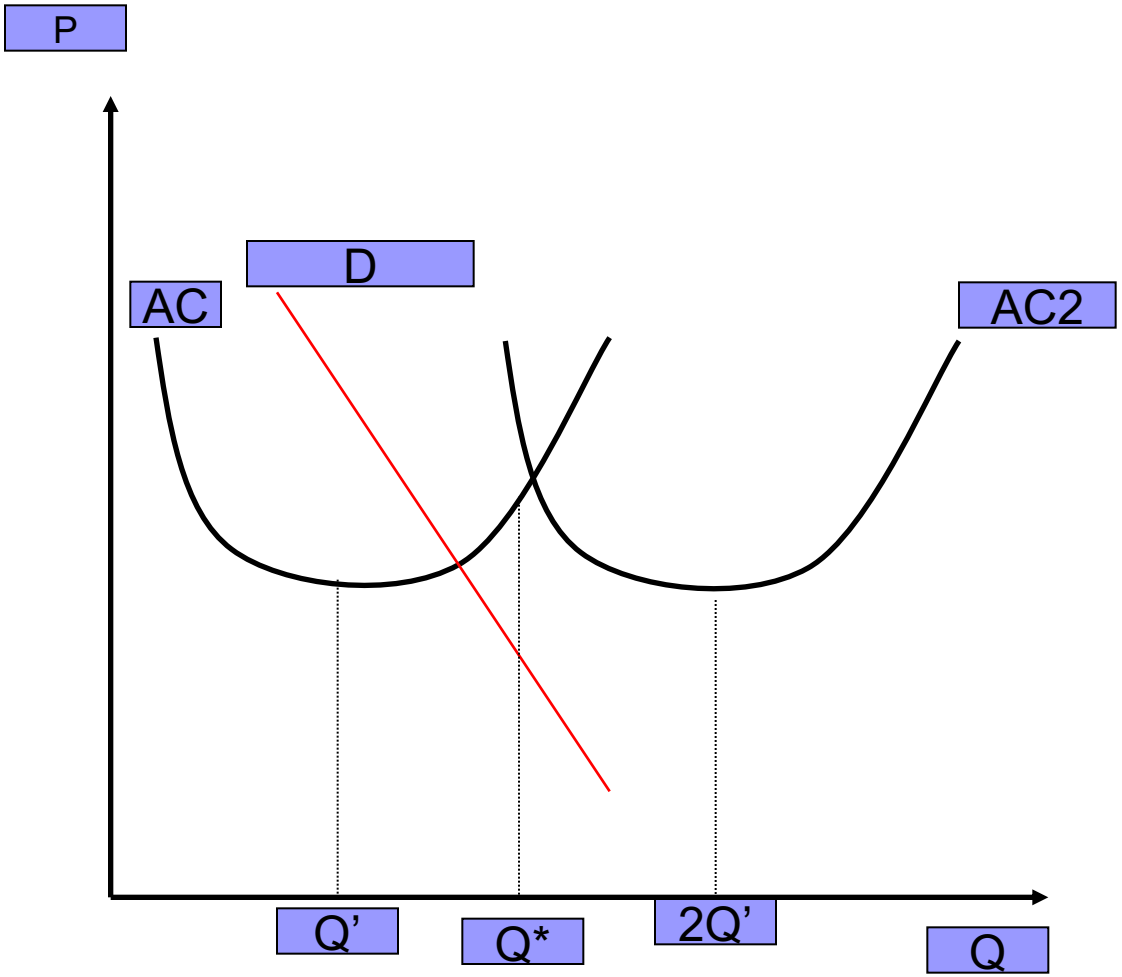


The cost falls to Q * and then stays constant. Beyond the Q * level of production, a functioning competitive market can be developed for D 'demand.

$$TC(Q_1 + Q_2) < TC(Q_1) + TC(Q_2)$$

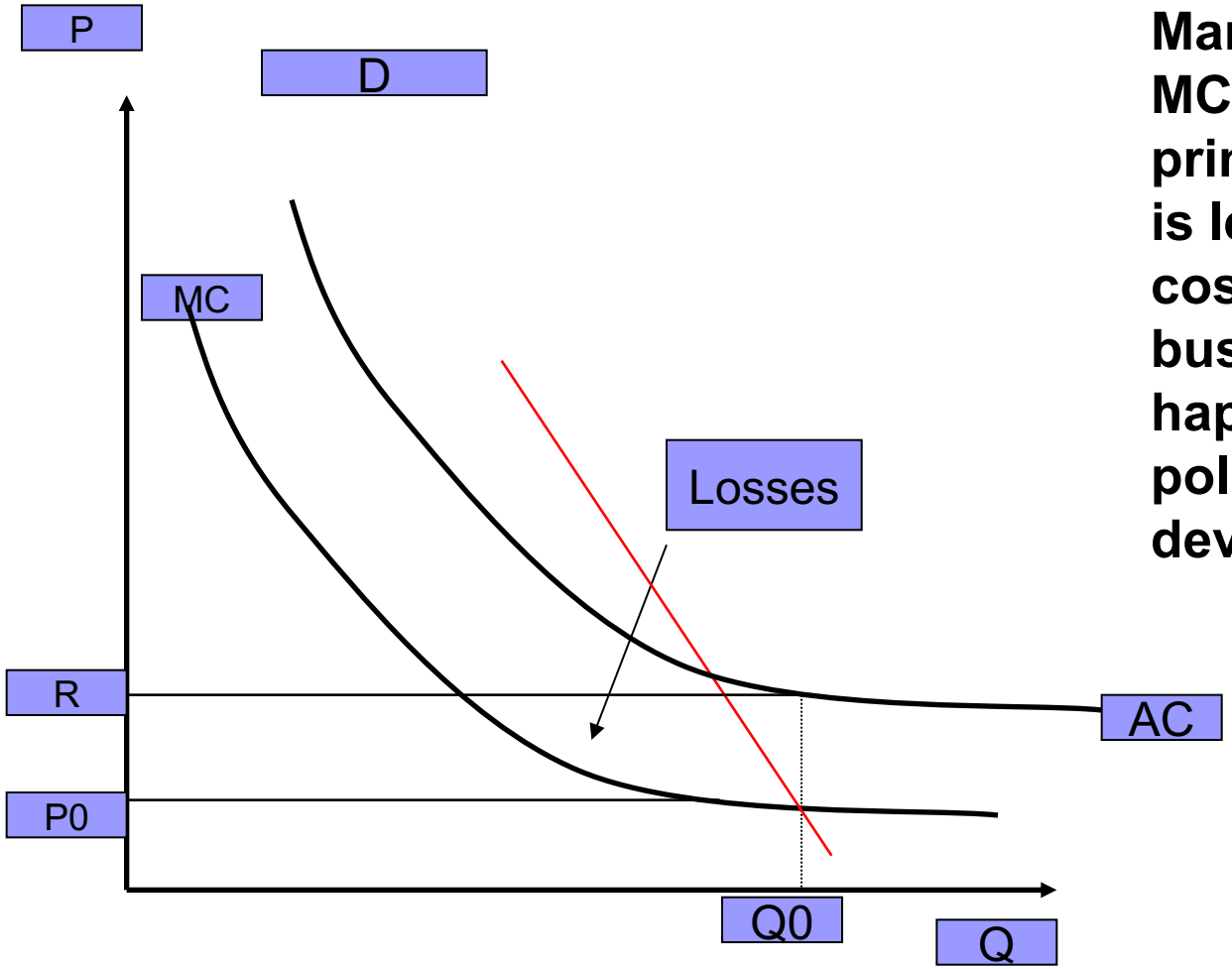
Sub-additive συνθήκη.
>Q';

Natural Monopoly III



What if someone tries to produce Q ', Q *, 2Q' quantities.When are economies of scale achieved?Is there scope for economies of purpose?

Natural Monopoly IV



Marginal cost pricing: P = MC. We apply this principle. Since the price is less than the average cost of production, the business is losing. What happens next? What policies are being developed?

Policy measures

- Subsidies reduce motivation and ability to control costs. On the other hand, management and employees know that the loss is subsidized and led to ineffective practices.
- Benefits paid by society from the production of a good are less than costs. In such a case, there is no excuse for producing the good. Subsidies may conceal this basic problem.
- Private enterprise subsidy is considered politically unacceptable in many countries.
- Lump-sum tax.

Literature

Ξένη:

- Bhattacharyya, Subhes C. (2011) Energy Economics: Concepts, Issues, Markets and Governance. Springer (Ch.8-9-12).
- Evans, Joanne and Lester Hunt,(2009), International Handbook on the Economics of Energy. Edward Elgar